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Kiln Drying Planning Tool

User Guide

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August 2008

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Introduction

Lumber drying is a transformation operation which aims at decreasing lumber moisture content in order to meet customers' requirements. Softwood lumber drying is realized by batches within large kiln dryers. In certain circumstances, special sections of the woodyard may be used to perform air drying. Air drying, which precedes kiln drying, may take several weeks but allows for the reduction of drying time in the kiln and energy consumption.

Lumber drying can be described as a two-stage transformation process which includes air drying and kiln drying. Each allowed combination of operations (i.e. each path in the graph of Figure 1) defines an alternative process that has a different usage rate of the resources (kilns, air-dry spaces and energy).

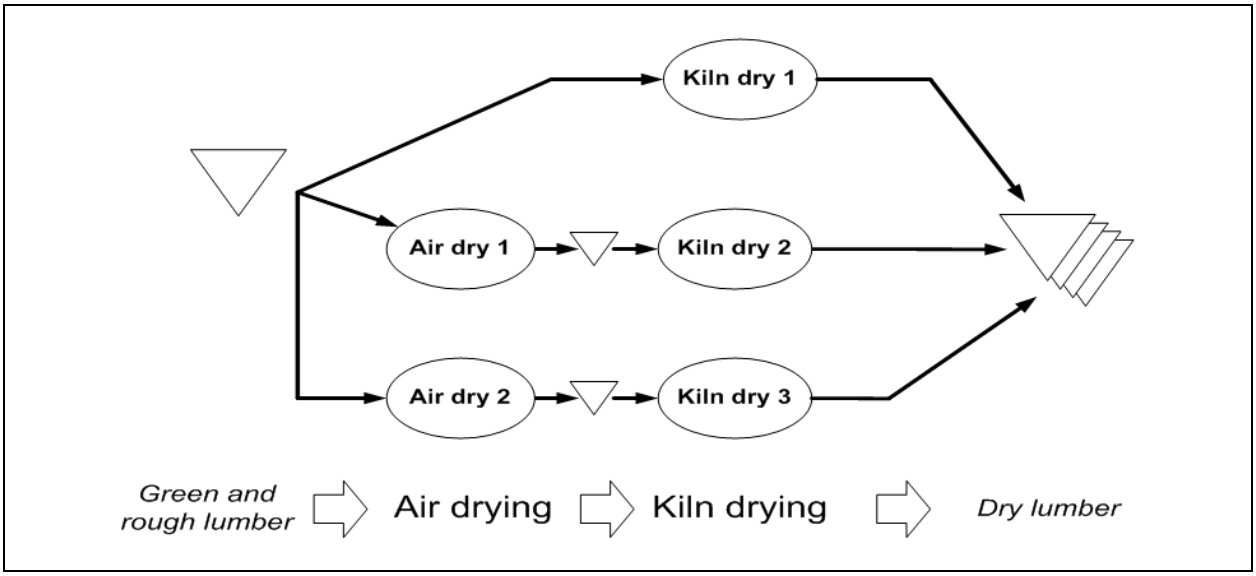


Figure 1: Alternative processes for a specific lot of lumber

For air drying, the various possible operations are mostly differentiated according to their durations. For kiln operations, they differ from one another according to air temperature, humidity parameters and duration. These parameters form a "kiln program". Each of these kiln programs may be considered as a distinct operation. The air drying operation has an impact on the kiln program to be used as the level of moisture content in the lumbers may vary depending on the duration and condition of the preceding air drying operation. The main impact is the reduction of drying time in the kiln, and thus a reduction in energy consumption.

Each kiln program has a different energy consumption and a lumber mill may have different kilns characterized by their size and drying technologies. Adding the air drying operation to the process increases the complexity in finding the best drying alternative considering the availability of green lumber and the production schedule for the planing of the dry lumber.

The present FORAC drying energy tool will help the production manager of a lumber mill to develop a strategy for planning the usage of air drying operations in combination with kiln programs in order to improve the overall efficiency of the drying operations. The final strategy will specify for which products to make use of air drying, at which period during the year and in combination with which kiln (possibly using different technologies) and kiln program. All of this is done taking into consideration the planing production schedule, the availability of green lumber and the storage and kiln capacity.

A two phase process

The use of the tool is a two phase process. In the first phase, you define the different alternative drying processes. A drying process describes one way of drying a given product family during a given season. For example, we could say that a drying process for the 2x4x8 balsam fir during autumn would be to use the air dry area for 3 weeks followed by 65 hours in kiln #2 using kiln program abc.

For a given drying process, you specify whether or not air drying is to be used and if so, the resources and cost required for that process. Similarly, for that process, we specify the resources, energy and cost required for kiln drying.

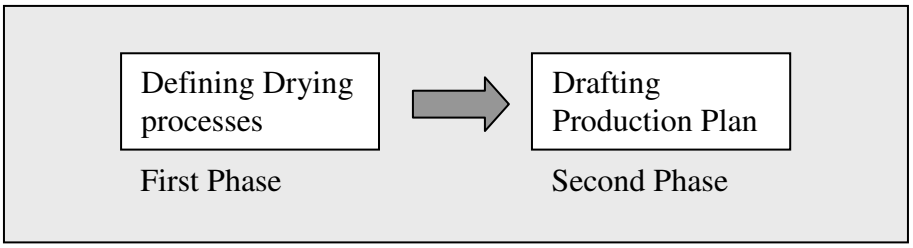


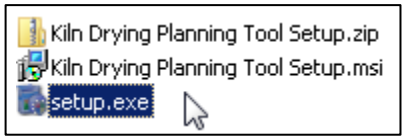
Figure 2: The two phase process of using the tool

Once the drying processes have been defined, the production manager can use the tool to make a production plan. That plan will take into consideration the sawing production that is the source for the green lumber, and the finishing production plan of the planing mill.

Transportation between mills

If there is more than one mill, the tool allows planning for the transportation of green rough wood and dry rough wood between mills. The tool will add to the production plan the cost and energy consumption for the transportation. The drying process can also be split between mills if air drying and kiln drying are done at different mills.

Installation of the tool



When you download the tool from Internet, you get the file *"Kiln Drying Planning Tool Setup.zip"*. You first have to unzip that file and then double click *"setup.exe"* which will proceed with the installation. The installation will create a new start up program menu item *"Kiln Drying Planning Tool"* under *"FORAC"*. If you accept all the default options of the installation, the program will install itself in the default *"Program Files"* windows directory under *"FORAC\Kiln Drying Planning Tool\"*.

Quick start

When you start the tool, it opens with a default template. From there you have three possible options:

1. Start creating a dataset from that template;
2. Choose a different template to start with;
3. Load a dataset that you have previously created and saved;

File extension

The file extension for the tool's datasets is *".etf"*. The three letters of the extension stand for "Energy Tool File".

Each time you save your dataset, a file name is required. If you use a file name that already exists, the old version of the file will be renamed with the .bak extension so that you can restore it if needed.

The navigation panel

The navigation panel is the center point of the tool. From there you decide what you want to do. As shown in the figure below, the navigation panel has been divided into five steps that can be followed in the creation of a dataset. Although these steps are a logical sequence for creating a new dataset, you can access these elements in any order to edit the information.

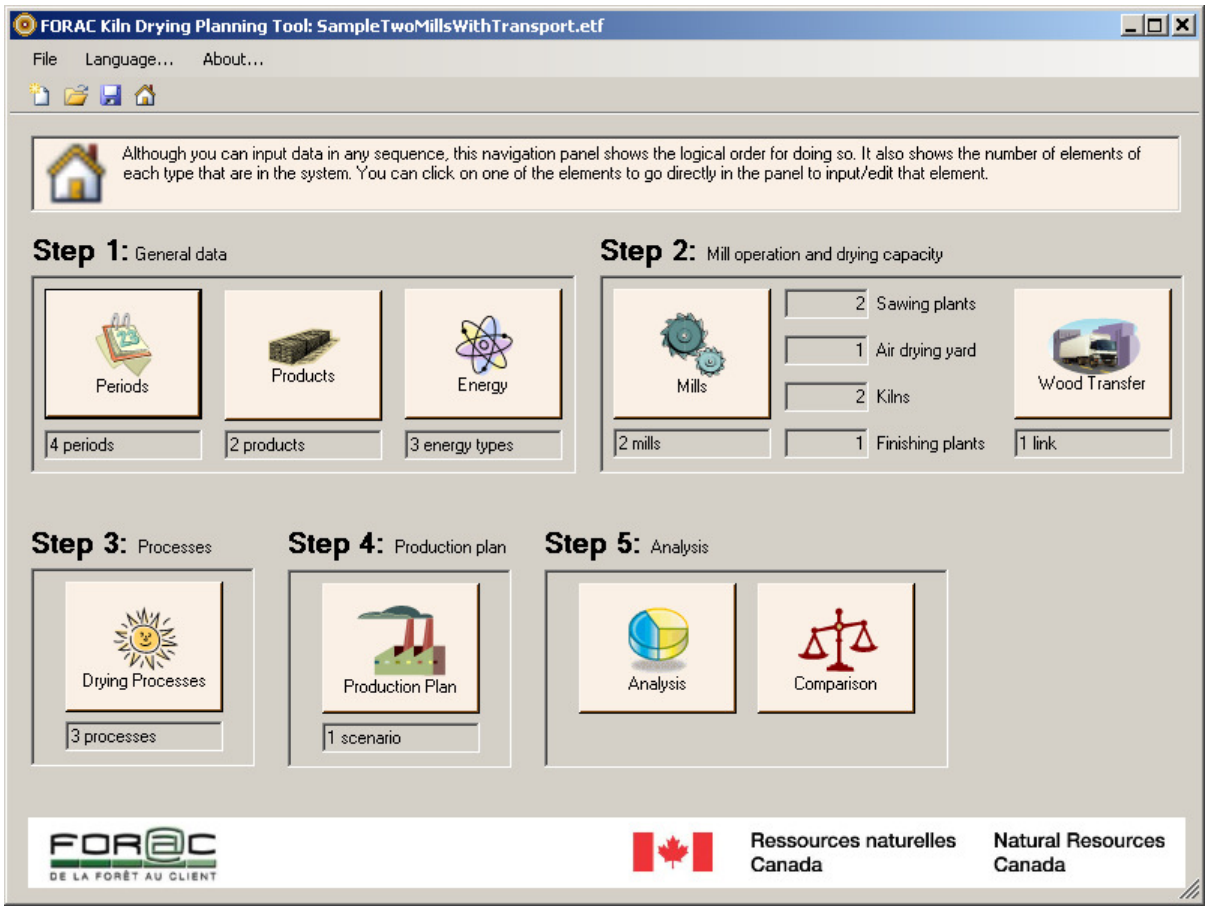

FORAC Kiln Drying Planning Tool: SampleTwoMillsWithTransport.etf
File
Language...
About...
Although you can input data in any sequence, this navigation panel shows the logical order for doing so. It also shows the number of elements of each type that are in the system. You can click on one of the elements to go directly in the panel to input/edit that element.
Step 1: General data
Periods
4 periods
Products
2 products
Energy
3 energy types
Step 2: Mill operation and drying capacity
Mills
2 mills
2 Sawing plants
1 Air drying yard
2 Kilns
1 Finishing plants
Wood Transfer
1 link
Step 3: Processes
Drying Processes
3 processes
Step 4: Production plan
Production Plan
1 scenario
Step 5: Analysis
Analysis
Comparison
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Figure 3: Navigation panel

The first step is for the general data that is used in other steps. It comprises the periods that are to be used for the planning, the products which will typically represent product families and the energy types used to compute the energy cost of a production plan.

The second step is related to the production resources available and the wood transfer general information. The options under this step may vary depending on your setup. If you have more than one mill, you will see the *"Wood Transfer"* button that will allow you to setup information pertaining to the transportation of green rough or dry rough between mills. If you have just one mill, Step 2 area will look like the one in Figure 4 below.

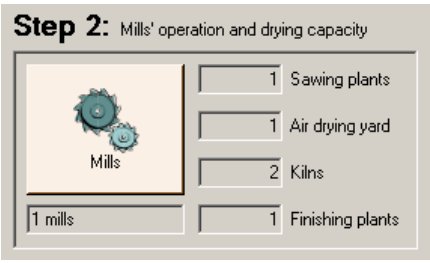


Figure 4: Step 2 Area when there is only one mill

The third step is for the definition of the building blocks used later in the *production plan* creation process. These building blocks are the drying processes used within the production plan. In *Step 4*, you create a production plan for each product (family) in each mill. While creating the production plan, you get immediate feedback on resource utilization and inventory levels.

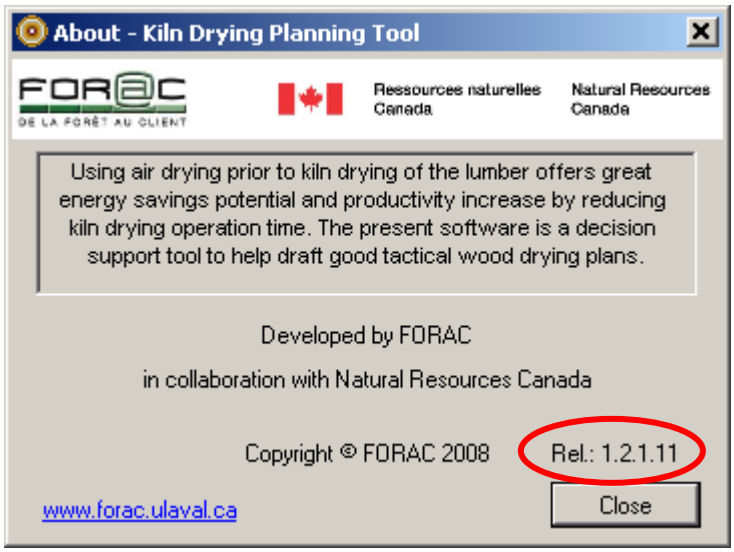
Finally, you can take a step back and analyze the performance of your production plan looking at the cost, the energy consumption, the greenhouse gases emitted and the volume of wood dried. The tool allows you to create different production plan (scenarios) and compare them with each others.

The application toolbar

From anywhere within the application, you can click one of the toolbar icons to create a new dataset ( ), load an existing one ( ), save your current dataset ( ) or go back to the navigation panel ( ).

The application menu

The application menu offers similar options to the application toolbar. The language option allows you to select your preferred language (French or English) for the application. Once selected, you have to restart the application for your choice to be effective. The application menu also allows opening the *About* dialog box which will give you the release [version] number of the tool you are using. If you have problems with the tool, we ask that you let us know the release number along with the description of the problem you are having. The figure below shows where you can find the release number on the *About* dialog box.


About - Kiln Drying Planning Tool
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Natural Resources Canada
Using air drying prior to kiln drying of the lumber offers great energy savings potential and productivity increase by reducing kiln drying operation time. The present software is a decision support tool to help draft good tactical wood drying plans.
Developed by FORAC
in collaboration with Natural Resources Canada
Copyright © FORAC 2008
Rel.: 1.2.1.11
www.forac.ulaval.ca
Close

Figure 5: About dialog box showing the tool release number

Grid menu

In many panels of the application you will see a grid for data entry and data display. Right clicking on these grids pops up a menu allowing you to copy the complete grid or only the selected cells. Some grids will also allow you to paste data copied from Excel sheets.

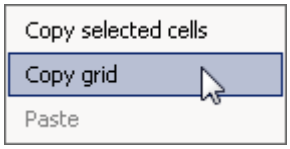


Figure 6: Contextual menu that pops up when right clicking on some of the grids

The templates

There are four templates that can be used to start up a new dataset with the tool. To open a template, select the menu option *File/New…* These templates reflect different kinds of basic scenarios that can be found in the industry. They are in fact samples from which you can start and modify in creating your own dataset. In all of the templates you will get four periods for the four seasons of the year. You will also get two products and standard energy types which can be used for running the kilns.

One of the templates is for the cases where only one mill is used. This is the simplest scenario and we suggest that you start with that scenario to familiarize yourself with the tool. Another scenario uses two mills but with no wood transfer between the mills. If, in fact, you do want to consider wood transfer between mills, you can base your dataset on a template having two mills and defining possible transportation links between the two. Finally, an empty template will create a dataset without sample data except for the energy types which contain predefined values for the computation of energy consumption and the emissions of greenhouse gases.

You cannot go wrong in initially selecting a template as they are really only sample datasets which can be changed to reflect your current situation.

Required data

General data

A few steps are required in setting up a new dataset. The first step is for the creation of the general data consisting of the periods that we want to use for the drying plan, the products and the different energy types that can be used by your kilns.

Periods

The periods are used because the kiln and air drying capacity can change in time, as well as the drying processes that can be used to dry a given product. You might also want to take into consideration sawing production and finishing production that are not necessarily constant throughout the year.

Since this tool is for tactical planning, the period length is typically a season, a quarter or a semester. You can adjust the periods in order to consider the freezing/thawing/non-freezing periods in your area. The figure below shows the panel used to setup the periods.

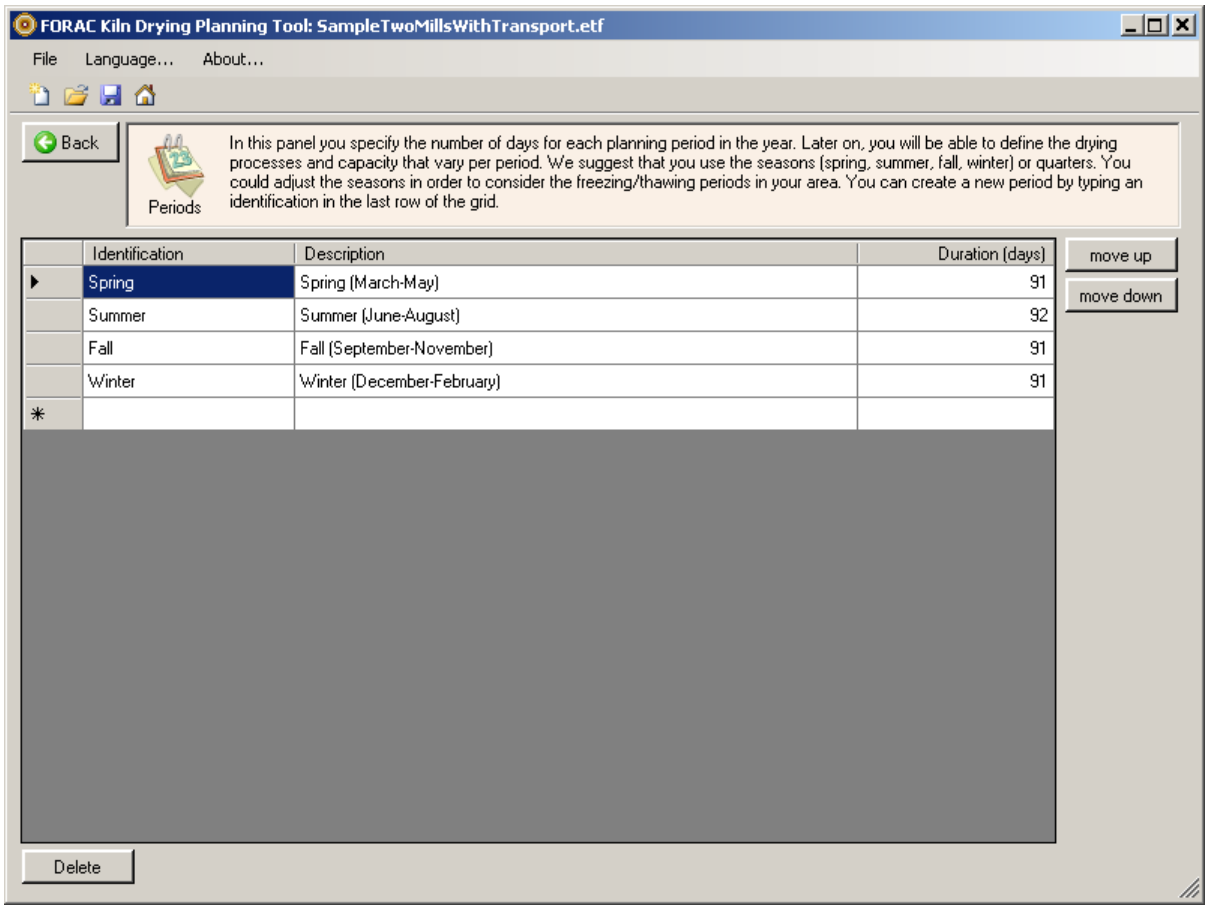

FORAC Kiln Drying Planning Tool: SampleTwoMillsWithTransport.etf
File
Language...
About...
Back
Periods
In this panel you specify the number of days for each planning period in the year. Later on, you will be able to define the drying processes and capacity that vary per period. We suggest that you use the seasons (spring, summer, fall, winter) or quarters. You could adjust the seasons in order to consider the freezing/thawing periods in your area. You can create a new period by typing an identification in the last row of the grid.
Identification
Description
Duration (days)
Spring
Spring (March-May)
91
Summer
Summer (June-August)
92
Fall
Fall (September-November)
91
Winter
Winter (December-February)
91
move up
move down
Delete

Figure 7: Panel for setting up the periods

Each period may have a different duration. The duration is used to compute the capacity of the mills that can perform air drying.

New periods can be created by typing text in the bottom row having an asterisk. The data can be edited directly into the cells of the grid.

Rows can be selected by clicking on the leftmost gray column. You can then delete or move up or down a selected row by clicking the corresponding button. Selected rows can also be deleted by depressing the *Delete* key. Deleting a period will remove all reference to it in the system.

The *move up* and *move down* buttons are provided to set the periods in chronological order. This is required for the inventory computation as the end of period inventory is used as the starting inventory of the following period. As will be seen in the section on production plan, the inventory computation is required to ensure enough green products are available for the drying plan and enough dry products are available for the finishing plan. The current period is the one you set at the top of the list. The current period is distinguished from the others because in the *production plan*, it is possible to set the starting inventory of that period while the starting inventory is computed automatically for the other periods.

Products

The tool considers different products because not all products require the same drying process. We recommend that you make a grouping of the products by families that can use the same drying processes. Using individual products with their SKU would add more difficulty in managing the information as you will have to build the production plan for the products you create. Keep in mind that the tool is for tactical planning to help balance air drying and kiln drying and ensure that enough resource capacity and inventory will be available for the finishing plan to be feasible.

Within the tool, we do not use a different code for the green product and the corresponding dry product. The tool retains the product status to differentiate between the two. Also, it is assumed that no scrap is generated from the drying process: 1 Mbf of product abc *green* will become 1 Mbf of product abc *dry* after the drying process.

Below is a figure showing the panel used to create and edit the products.

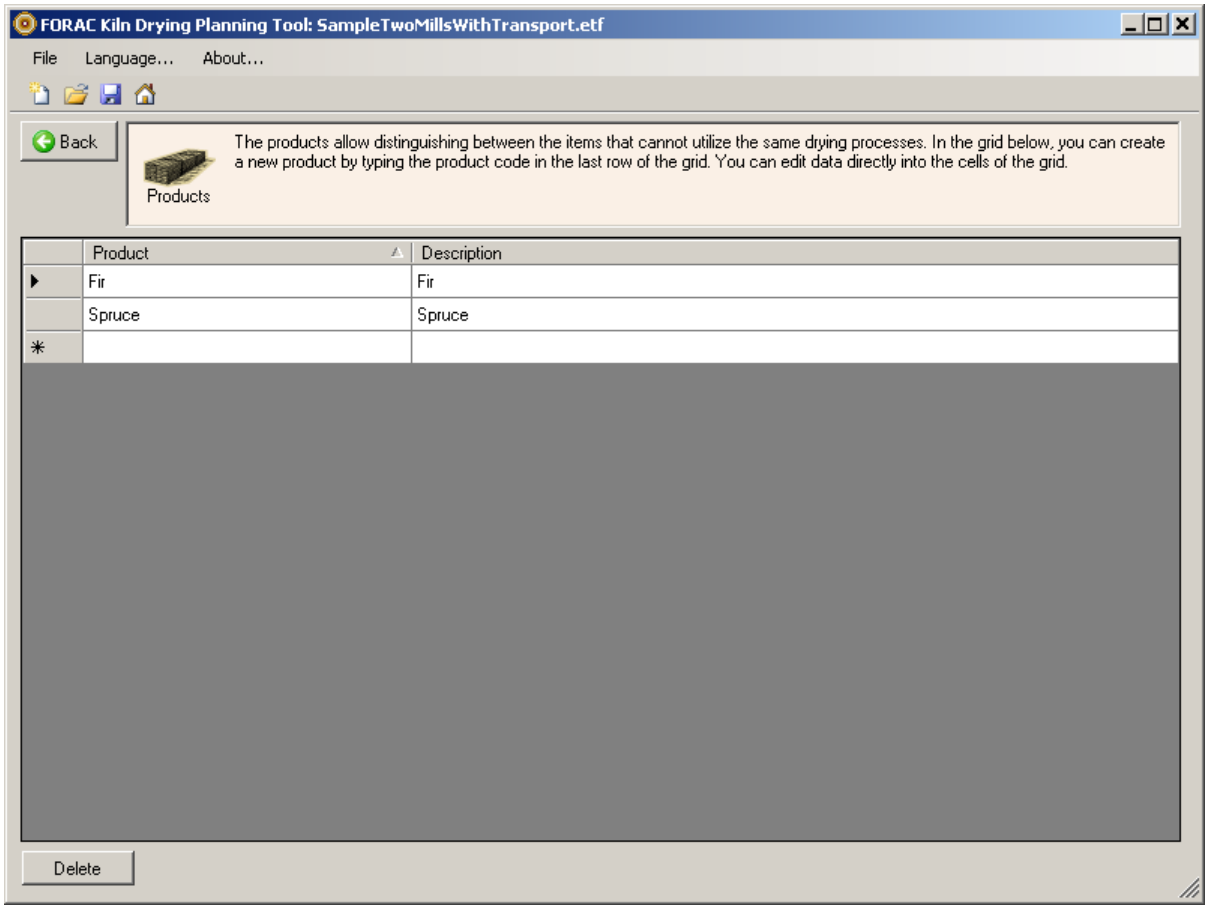

FORAC Kiln Drying Planning Tool: SampleTwoMillsWithTransport.etf
File
Language...
About...
Back
The products allow distinguishing between the items that cannot utilize the same drying processes. In the grid below, you can create a new product by typing the product code in the last row of the grid. You can edit data directly into the cells of the grid.
Products
Product
Description
Fir
Fir
Spruce
Spruce
Delete

Figure 8: panel for setting up the products

As for the periods, products are created by typing text in the last row of the grid. To delete a product, you should first select the row by clicking on the left column and then click the *Delete* button or depress the *Delete* key.

Deleting a product will remove all reference to it in the system. The production plan for that product will be discarded.

Energy

The energy panel is used to define the different types of energy that can be used by your kilns. Setting up energy types and linking them to your kilns will allow for the automatic calculation of the energy cost, the energy content (in MJ) and the emissions of greenhouse gases (in kg of CO_2) resulting from a given production plan. This information will help you determine how efficient your production plan is in regards to cost, energy and greenhouse gases emission.

The figure below shows the panel used to create and edit the energy types. New energy types can be created by typing text in the last row of the grid. To delete an energy type, you must first select the row by clicking on the leftmost column and then click the *Delete* button at the bottom or depress the *Delete* key. Values can be edited directly in the cells.

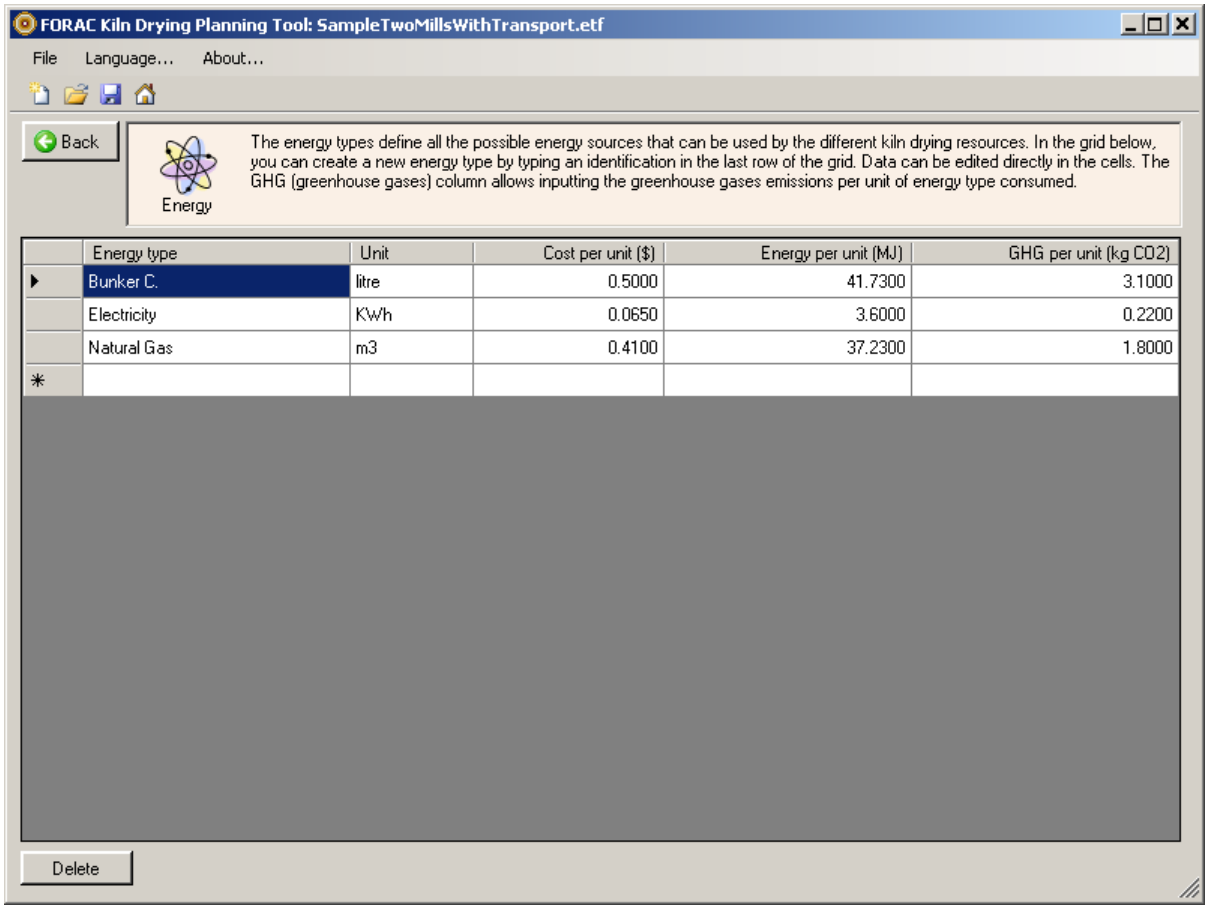

FORAC Kiln Drying Planning Tool: SampleTwoMillsWithTransport.etf
File
Language...
About...
Back
Energy
The energy types define all the possible energy sources that can be used by the different kiln drying resources. In the grid below, you can create a new energy type by typing an identification in the last row of the grid. Data can be edited directly in the cells. The GHG (greenhouse gases) column allows inputting the greenhouse gases emissions per unit of energy type consumed.
Energy type
Unit
Cost per unit ($)
Energy per unit (MJ)
GHG per unit (kg CO2)
Bunker C.
litre
0.5000
41.7300
3.1000
Electricity
KWh
0.0650
3.6000
0.2200
Natural Gas
m3
0.4100
37.2300
1.8000
Delete

Figure 9: panel for editing and creating energy types

The link between the energy types and your kilns is done in the *Mills* panel where you can specify the number of units used on average per hour of running each kiln. This is just a default value that can be overwritten later when defining drying processes.

The cost per unit of using an energy type might need to be updated from time to time as the prices of the different energy types will change. It is your responsibility to keep these values up-to-date. The energy per unit and the greenhouse gases (GHG) emitted per unit are more difficult to find but will not change over time. The tool comes with predefined energy content and GHG emission rate for a few energy types. The CO_2 emissions related to the use of electricity may

vary per province. The table below shows the average CO_2 emissions by unit of electricity produced in Canadian provinces in 1998 (source: CIPEC Energy Efficiency Planning and Management Guide, Natural Resources Canada - Office of Energy Efficiency, Cat. No. M92-239-2001E).

Province	kg CO_2 / KWh
Atlantic	0.25
Québec	0.01
Ontario	0.23
Manitoba	0.03
Saskatchewan	0.83
Alberta	0.91
British-Columbia	0.03
Territories	0.35
Canada	0.22

Mill operations and drying capacity

Mill operations of interest for the tool are sawing, air drying, kiln drying and finishing. Also, if more than one mill is considered, wood transfer between mills can occur.

Mills

Under the mills panel, there are three tabs: Mills, Air drying and Kiln drying. The *Mills* tab is used to edit the mills for which you want to plan the drying. For each mill, check the operations that are performed at the mill. The figure below shows the *Mills* tab.

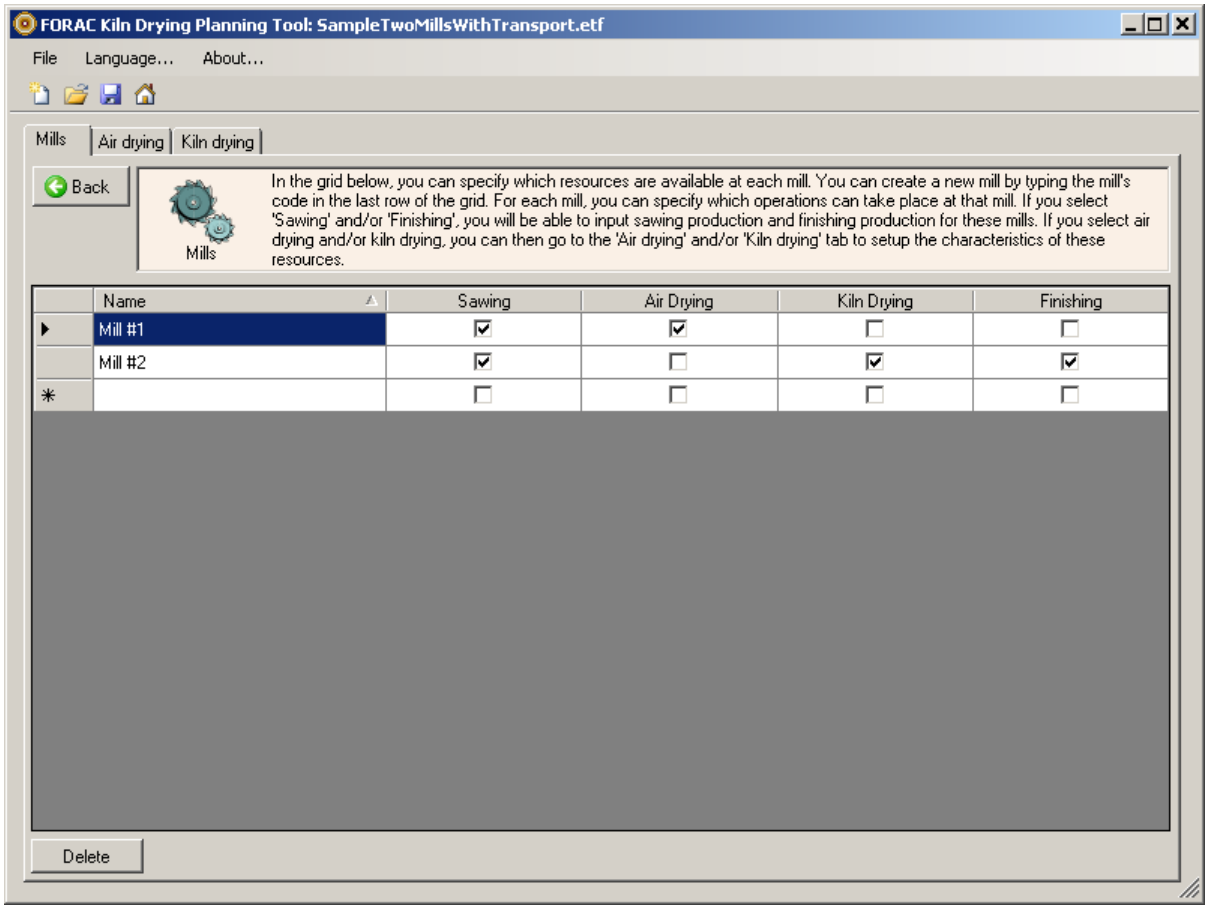

FORAC Kiln Drying Planning Tool: SampleTwoMillsWithTransport.etf
File
Language...
About...
Mills
Air drying
Kiln drying
Back
Mills
In the grid below, you can specify which resources are available at each mill. You can create a new mill by typing the mill's code in the last row of the grid. For each mill, you can specify which operations can take place at that mill. If you select 'Sawing' and/or 'Finishing', you will be able to input sawing production and finishing production for these mills. If you select air drying and/or kiln drying, you can then go to the 'Air drying' and/or 'Kiln drying' tab to setup the characteristics of these resources.
Name
Sawing
Air Drying
Kiln Drying
Finishing
Mill #1
Mill #2
Delete

Figure 10: Mills tab selected in the mills panel

Checking *Sawing* for a given mill will allow you to enter the sawing production per period for that mill (in the production plan). Sawing production allows increasing the green rough inventory that can be dried. You have to check *Air Drying* if you want to use air drying at that mill. The mill will also appear in the *Air drying* tab and let you enter the yard volume that can be used for air drying per period. Check *Kiln Drying* if you have kilns at a given mill. You will then have access to edit the kilns characteristics (like the volume and the energy sources) in the Kiln *drying tab*. Finally, checking *Finishing* for a given mill will allow you to enter the finishing production per period for that mill (in the production plan). Finishing production at a mill will decrease the dry rough inventory at that mill in order for you to monitor your inventory level and ensure enough green wood will be dried for a given finishing plan.

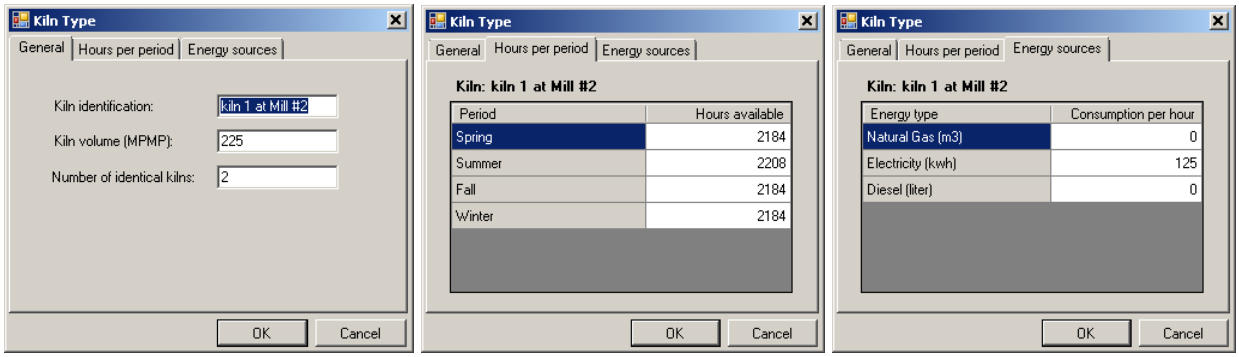
New mills can be created by typing text in the last row of the grid. You can delete a mill by selecting the row of that mill and then either click on the *Delete* button or depress the *Delete* key. Deleting a mill will remove all references to that mill in the system.

Air drying tab

The *Air drying* tab allows for the setup of the yard volume per period that can be used by the mills for air drying. You edit the volume in Mbf directly in the cells of the grid.

Kiln drying tab

In the *Kiln drying* tab, you can create and edit the different kilns available at each mill. Identical kilns can be grouped together under the same identification. For a given kiln type, you can specify the volume of lumber that can go into the kiln in one batch and the number of kilns of that type available at the mill. Availability and energy consumption of the selected kiln type can also be specified by clicking on the *Detail* button at the bottom of the window, by double clicking the row or by clicking the ... button at the end of the row. This opens a dialog window with three tabs to setup the kiln. The first tab (General) lets you set the kiln identification, the kiln volume in Mbf and the number of identical kilns. To be considered identical for this tool, the kilns must have the same capacity, they must have the same average consumption of the same energy type and they must have the same amount of hours available.



The number of hours available per period and per kiln is used to draw the kiln capacity in the *Kiln Usage* chart of the production plan. This helps determine if a production plan is feasible or not. The consumption per hour for the different energy types is a default value as it can be more

specific to the process being used. More precise values can be used when defining drying processes.

Wood Transfer

This panel will be available only if you have more than one mill. It allows editing the information required to compute the cost, energy and greenhouse gases emitted due to the transfer of wood between mills. A transfer of wood between two given mills will be possible only if you set up a link between these two mills in the *Distance matrix* tab.

A wood transfer of green wood will automatically occur if you utilize a process that uses air drying and kiln drying and if these operations are done at different mills. In the production plan, you can also manually create a wood transfer between mills if, for example a mill has sawing capacity but no drying capacity. This is also the case if you want to do wood finishing at a different location than where the wood was dried.

If all the parameters for the wood transfer from mill A to mill B are the same as from mill B to mill A, and you do in fact want to consider wood transfer flows in both directions, you can set the parameters for only one direction and the tool will assume they are the same for the opposite direction.

To keep the system simple, you only set and average cost per Mbf dry and green over the total distance traveled. This cost must include the fuel cost.

A new link can be created by selecting a mill or typing a value in the last row of the grid. You can delete a link by selecting the row of that link and then either click on the *Delete* button or depress the *Delete* key. Deleting a link will remove all references to that link in the system. It means that if a drying process was using that link, the drying process will also be removed from the system.

As shown in the figure below, the energy required for the transfer of wood and the greenhouse gases emitted during transfer is also taken into consideration. The parameters in the tab *Greenhouse gases* are used to compute these values.

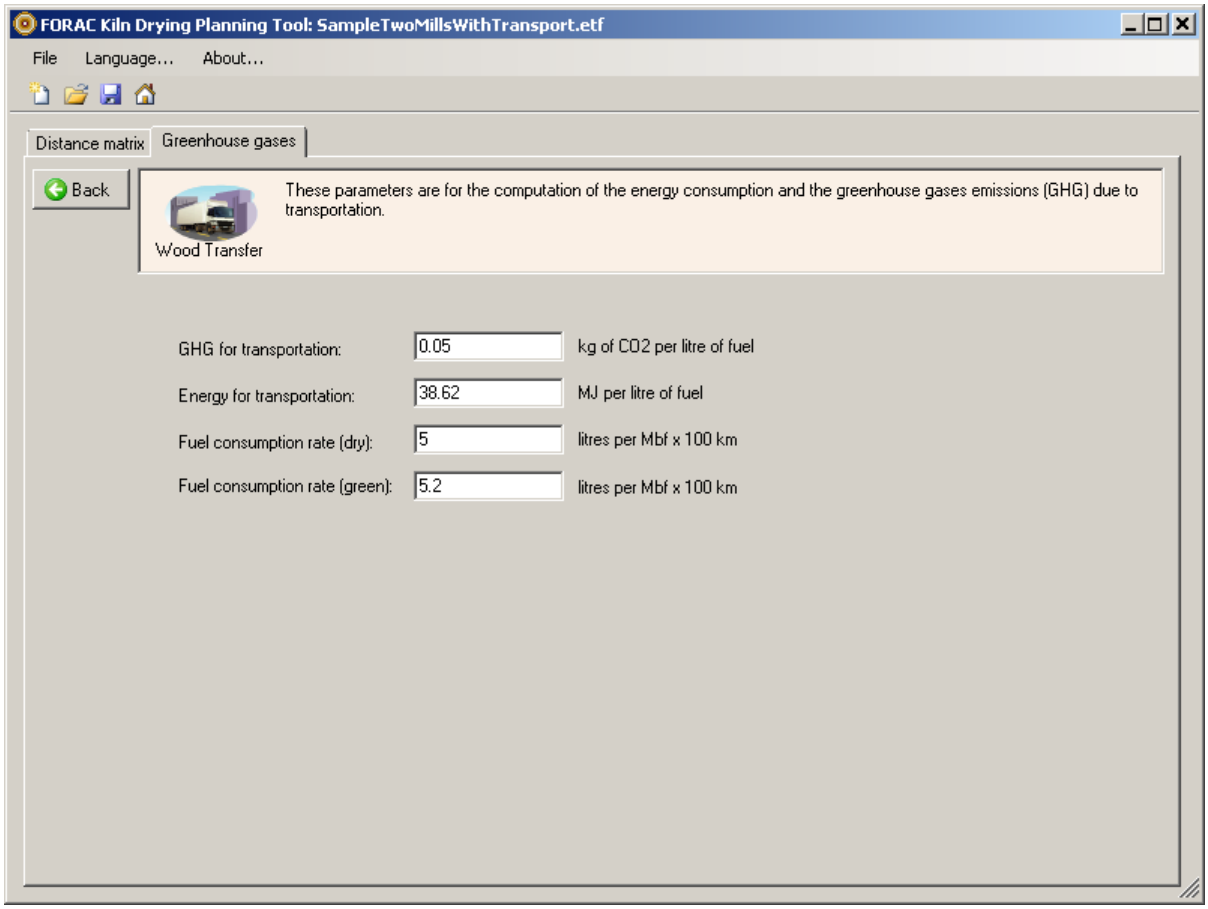


Figure 11: parameters for energy and greenhouse gases emission due to wood transfer

For the greenhouse gases (GHG), the default value of 0.05 kg of CO_2 per litre of fuel consumed is true for the diesel. If you are using another type of fuel and want to know the exact emission rate, please contact us and we will try to help you find the right value.

The same remark applies to the energy rate with the default value of 38.62 MJ per litre of diesel consumed.

Drying Processes

A drying process is a predefined sequence of one or two drying operations (air drying followed by kiln drying) that can be used as a drying alternative for a given set of products in a given set of periods.

The drying processes are used in making the production plans. This is why you should create all your drying processes before you start building your production plan.

Many factors make a drying process unique. To start with, there is the fact that it is made up of just air drying, just kiln drying or a combination of both. A drying process also specifies the mill for the air drying. Therefore, two air dry operations with the same duration to be done at different mills would be considered different drying processes. The air dry duration (in days) is another factor that differentiates drying processes.

For kiln drying, the specific kiln to be used at a given mill as well as the time in the kiln is a characteristic of the drying process.

The figure below shows the panel to edit the drying processes. The processes are displayed in a grid with a summary of the air drying mill and duration, the kiln used for drying with the duration and the energy, greenhouse gases emissions and cost of the process.

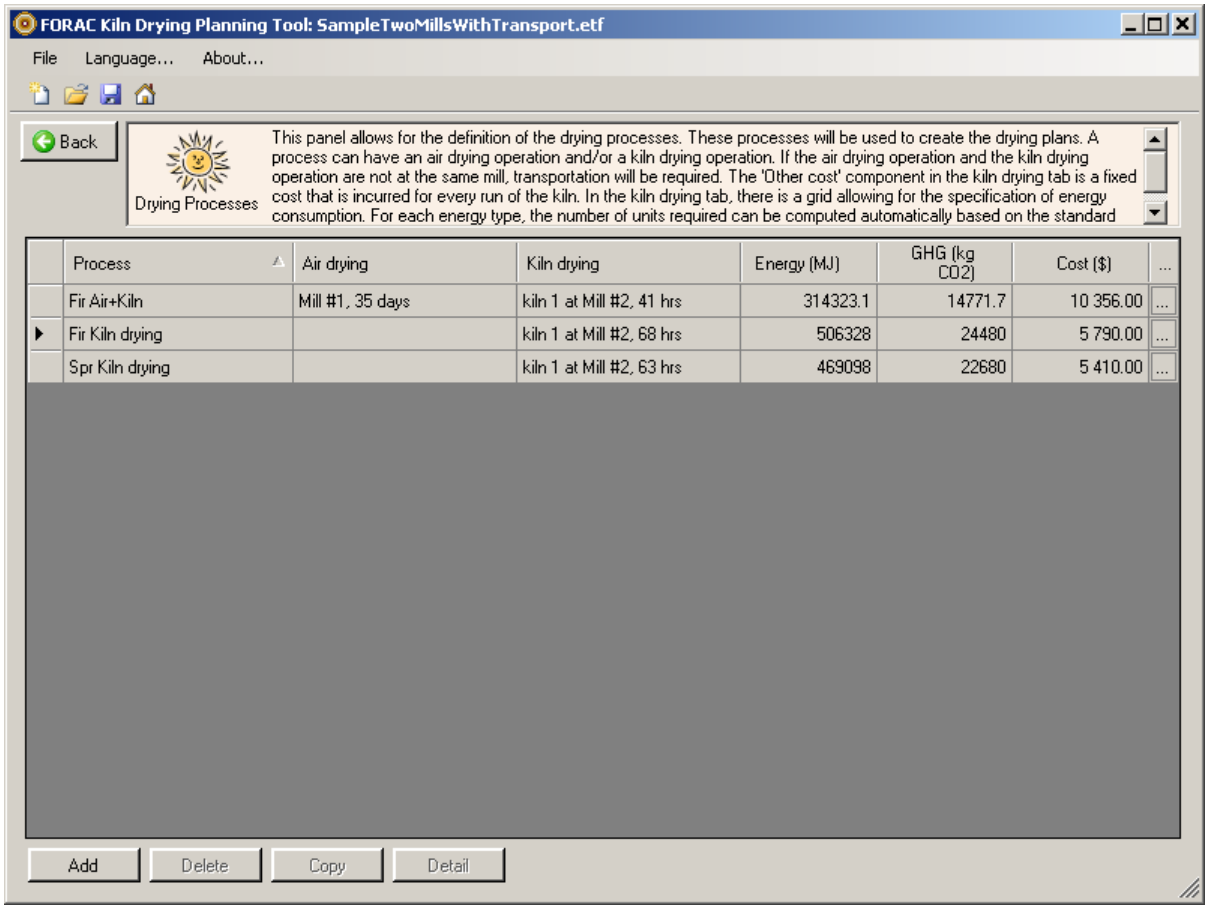

FORAC Kiln Drying Planning Tool: SampleTwoMillsWithTransport.etf
File
Language...
About...
Back
Drying Processes
This panel allows for the definition of the drying processes. These processes will be used to create the drying plans. A process can have an air drying operation and/or a kiln drying operation. If the air drying operation and the kiln drying operation are not at the same mill, transportation will be required. The 'Other cost' component in the kiln drying tab is a fixed cost that is incurred for every run of the kiln. In the kiln drying tab, there is a grid allowing for the specification of energy consumption. For each energy type, the number of units required can be computed automatically based on the standard
Process
Air drying
Kiln drying
Energy (MJ)
GHG (kg CO2)
Cost ($)
Fir Air+Kiln
Mill #1, 35 days
kiln 1 at Mill #2, 41 hrs
314323.1
14771.7
10 356.00
Fir Kiln drying
kiln 1 at Mill #2, 68 hrs
506328
24480
5 790.00
Spr Kiln drying
kiln 1 at Mill #2, 63 hrs
469098
22680
5 410.00
Add
Delete
Copy
Detail

Figure 12: Panel to edit the drying processes

A list of buttons at the bottom of the panel allows you to add, delete, copy or view/edit the details of the selected drying process. You can also delete the selected process by depressing the *Delete* key. Deleting a process used in a production plan will also delete that process from the production plan.

Another way of editing or viewing the details of a drying process is by clicking on the ... button at the end of the row of the process to edit/view. This action opens a dialog window with five tabs.

Summary tab

The first tab is a summary showing the process name along with a short description of the process. It also shows the cost, energy and greenhouse gases for the process itself and for the wood transfer when the air drying operation and the kiln drying operation take place at different mills. The cost is for processing (and transferring if applicable) a volume of wood equivalent to the capacity of the kiln. If the process is only an air drying process, then the cost is for the air drying of 1 Mbf.

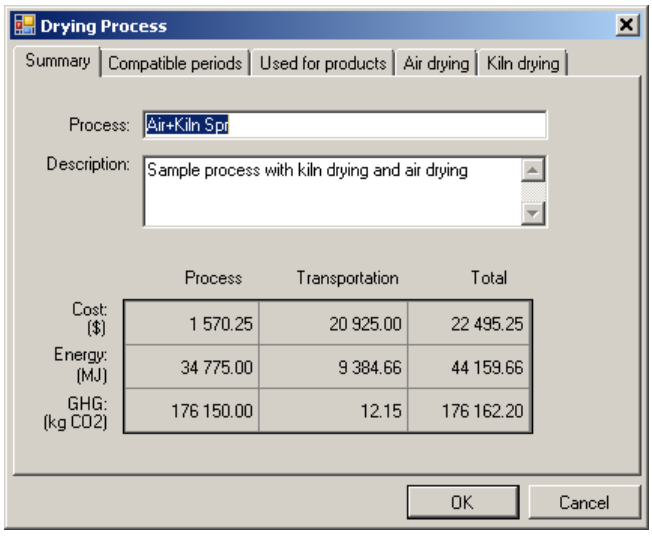


Figure 13: Summary tab of the dialog window to edit a drying process

Compatible periods and products tabs

The tool allows you to be restrictive of the periods in which it can run. For example, some air drying operations cannot be done during winter. Another example is the air drying or kiln drying

time that is different in winter and in summer. In these conditions you have to create a different drying process for the winter and for the summer.

It is also possible for a drying process to be the same for more than one product. The *Used for products* tab captures this option by letting you check all the products to which the process applies. Checking more than one product does not mean they will all go together in the kiln. It just means the process characteristics apply to all the checked products: they will be dried at the same mill and it will take the same amount of time.

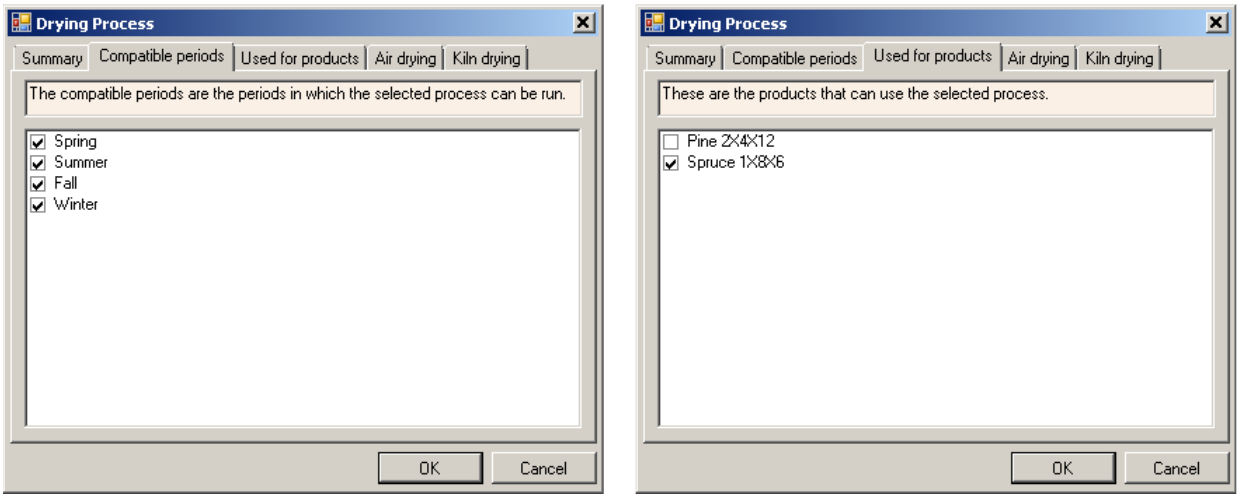


Figure 14: Compatible periods and products tabs of the dialog window to edit a drying process

When you create products and periods in the products and periods panels, they are not automatically added to any process. New products and periods must be checked for all the processes to which they apply.

Air drying tab

If your drying process does make use of air drying, you check the *use air drying* check box within the air drying tab. If you have more than one mill, you specify the mill where the air drying takes place and the duration of the air drying operation, in days.

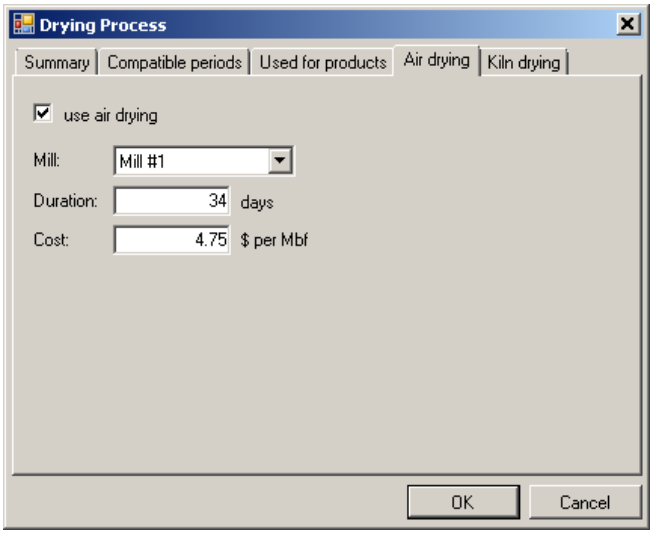


Figure 15: Air drying tab of the dialog window to edit a drying process

Optionally, if you want to compute the cost of your production plan, you will set a cost per Mbf of wood air dried for the duration of the operation.

Kiln drying tab

As for the air drying tab, if your drying process does make use of kiln drying, you check the *use kiln drying* check box within the kiln drying tab. If you have more than one mill, you specify the mill where the kiln drying takes place and then the specific kiln to be used. The duration is set in hours and the *Other Cost* component is applicable every time the kiln dries a new batch. It may represent a cost for preparing the wood before it entered the kiln.

The hour duration is used to compute the kiln usage for a given production plan and compare it to the kiln capacity. It is also used in computing the number of units of each energy type required to complete the process. As we saw in a previous section, the resource utilization can be automatically computed based on the duration of the kiln operation and the default consumption rate at the kiln. Now that we know the exact process for which the kiln will be used, we can adjust the number of units of each energy type that will be used by the process for the drying operation. To manually set the number of units that is to be used by the kiln during the operation, you have to uncheck the *Auto* check box and then put a value in the *Num units* column.

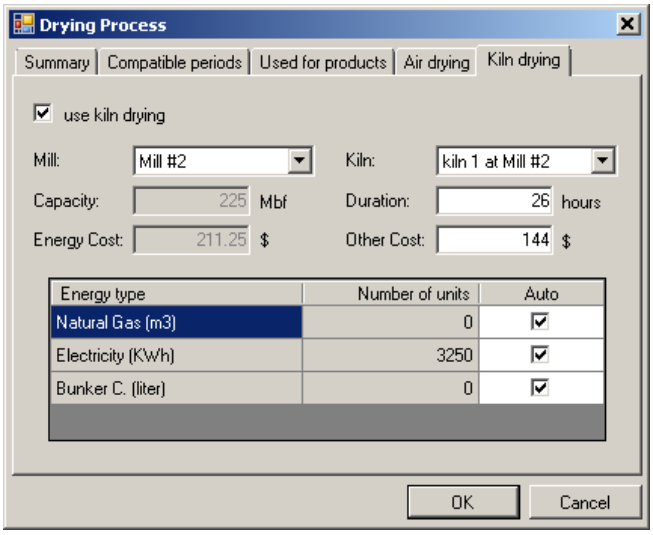


Figure 16: Kiln drying tab of the dialog window to edit a drying process

If the kiln selected for the kiln drying is at a different location than the air drying, a wood transfer will automatically occur when using this process. To be able to define such a process with drying operations done at different mills, you must previously have defined a link between these mills in the *Wood Transfer* panel which you access from the navigation panel.

Building a production plan

In the production plan, you not only setup the drying plan but you can also synchronize it with the sawing production and the finishing production. The objective is to have enough dry rough inventory to supply the finishing production while not exceeding the drying capacity of the mills.

If your dry rough inventory is negative, it means your production plan is not synchronized and you need to make adjustments. There are several ways to increase the dry rough inventory available at a given mill: you can either increase the supply of dry rough or decrease the demand. To increase the supply, you can either dry more wood or get dry rough wood from another mill. Decreasing the demand is done by reducing the finishing production.

In drying more wood, you reduce the green rough inventory. If it falls below the zero level, it means your production plan is not synchronized. You could look into ways of increasing the sawing production or get green rough from another mill having excess green wood. Another

alternative is to dry some of the required dry rough at another location and then ship it to the mill where the finishing will be done.

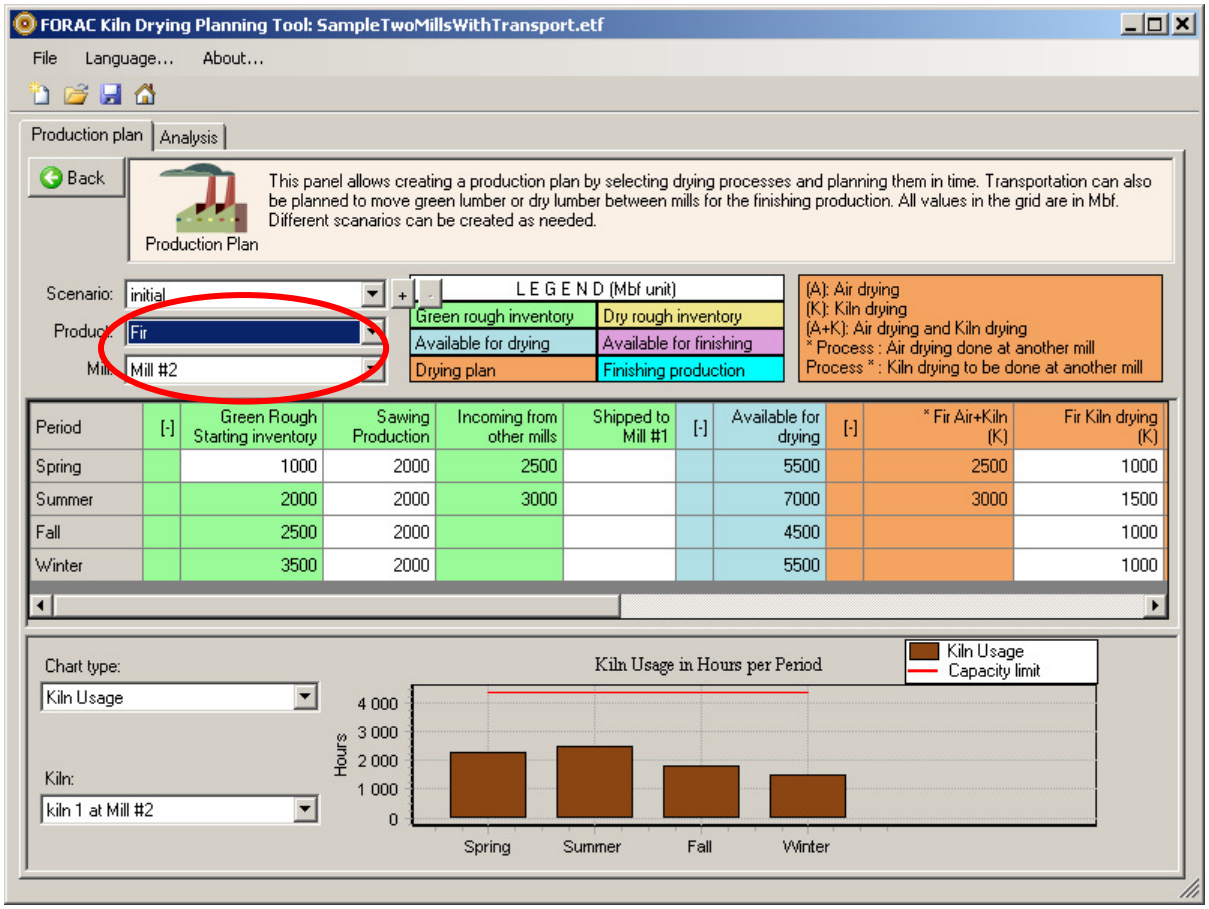
The tool will not prevent you from planning to dry more wood than your available capacity. It will only show you what your kilns planned utilization is for your current production plan. If the planned utilization is beyond the kilns' capacity, it is up to you to change the plan. You could for example change some of the process used for drying; perform the drying at another period when the kilns are less utilized; dry the wood at another mill where drying capacity is not an issue.

Building a production plan is not a straightforward process. It is rather a trial and error process that continues till you have no negative inventory and no over-utilized resource.

The tool focuses on the drying aspect of the production plan. For this reason, it manages neither the sawing capacity nor the finishing capacity. The sawing production and the finishing production are there only to help you synchronize your drying plan.

Understanding the grid

To ease the creation process of the production plan, you see and edit only a portion of it at the same time. The slice of the production plan that you see is for a given product at a given mill. The product and mill for which the production plan is displayed is shown in the upper portion of the panel (see figure below). In the following sections, we will refer to them as the *current* mill and *current* product.



Period	[-]	Green Rough Starting inventory	Sawing Production	Incoming from other mills	Shipped to Mill #1	[-]	Available for drying	[-]	* Fir Air+Kiln (K)	Fir Kiln drying (K)
Spring		1000	2000	2500			5500		2500	1000
Summer		2000	2000	3000			7000		3000	1500
Fall		2500	2000				4500			1000
Winter		3500	2000				5500			1000

Figure 17: The production plan panel

In the *Production plan* panel, the production plan is an integrated grid showing the sawing production, the drying plan and the finishing production. All quantities in the grid are in Mbf. You can edit all of these plans directly in the integrated grid. To help you ensure these plans are synchronized, the grid shows the inventory level of green rough and dry rough.

The grid is divided into coloured sections which can be collapsed or extended depending on what you want to see. You can collapse or expand a section by clicking on the column header having [+] or [-] symbols.

In the grid itself, you will see coloured cells and white cells. The white cells are the one that can be edited. The coloured ones display computed values.

A legend helps you quickly grasp what each section is all about:

LEGEND (Mbf unit)	
Green rough inventory	Dry rough inventory
Available for drying	Available for finishing
Drying plan	Finishing production

We will examine each of these sections in detail.

Period

The first section cannot be expanded or collapsed. It is the ordered list of periods used in the plan. The first period on the top is the current period for which we can set the starting inventory. To reorder the periods or change the current one, you have to be in the *Periods* panel.

Green rough inventory

In the *green rough inventory* section, you see all the quantities which have an impact on the quantity of green rough that is available for drying in each period. The column *Starting inventory* is the inventory of green rough that is in stock at the mill when the period begins. For the current period (the first one in the column), that value has to be typed in while it is computed for the other periods. If sawing is possible at the mill (if check box *Sawing* in the *Mills* panel is checked), you can type the sawing production in the corresponding column of the grid. That production will be added to the starting inventory and be available for drying during the period.

The column *Incoming from other mills* is read only. It shows manually planned shipments of green rough from other mills. It also shows partially dried wood (air dried only) that should arrive if a process is planned having an air drying operation at another mill and a kiln drying operation at the current mill. That green rough incoming from other mills is also available for drying in the period.

Finally, if you have more than one mill with transfer links defined, you will see columns *Shipped to…* that will allow you to manually plan shipments of green rough to other mills. These shipments reduce the volume that is available for drying.

Available for drying

The column *Available for drying* shows the volume that can be used for drying at the current mill. It is the starting inventory plus the sawing production plus what is incoming from the other mills minus the quantities shipped. The volume available for drying that does not go into the drying plan constitutes the starting inventory of the following period.

Drying plan

In the drying plan section, you will see one column per process that can take place at the current mill for the current product. When a process is not allowed to run in a given period, the cell will be coloured and read only in the grid, as in the figure below.

Period	Kiln drying Pine (K)
Spring	345
Summer	
Fall	1 000
Winter	1 200

Figure 18: In this example, the process *Kiln drying Pine* is not allowed to run in the period *Summer*.

For each process, you can edit in the cell the volume to be dried (in Mbf) using that process. When doing so, the tool recalculates the inventory levels and the kiln usage.

The columns headers of this section gives you some information on the drying process. When you see "(K)", like in the Figure 18, it means it is a kiln drying operation only. When you see "(A)", it means the operation at the mill is air drying only. You will see "(A+K)" when both the air drying operation and the kiln drying operation at done at the mill. Sometimes, you will also see an asterisk just before the process name or just after it. When there is an asterisk preceding the process name, it means an air drying process was done at another mill. When the asterisk is just after the process name, it means the kiln drying operation will be done at another mill to complete the drying process. If you leave your mouse idle over the column title for a few seconds, a tooltip will appear showing which other mill is involved in the drying process. Beside from the legend is a table to remind you of these conventions (Figure 19).

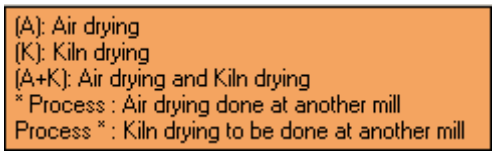

(A): Air drying
(K): Kiln drying
(A+K): Air drying and Kiln drying
* Process : Air drying done at another mill
Process * : Kiln drying to be done at another mill

Figure 19: convention for the process columns header

The column *Total dried* shows the total volume of the current product that is going through a drying process at the current mill during the period. Some of that volume will become available for the finishing production. Some will need to undergo kiln drying at another mill and will thus not be available for finishing production at the current mill.

It is important to mention that we assume that if a process has started in a given period, it will be completed in that same period, meaning that the dried lumber will be available for the finishing production planned at that same period.

In the *dry rough inventory* section, you see all the quantities which are having an impact on the quantity of dry rough that is available for finishing in each period. The column *Starting inventory* is the inventory of dry rough that is in stock at the mill when the period begins. For the current period (the first one in the column), that value has to be typed in while it is computed for the other periods. A negative inventory value will be shown in red, as in Figure 20.

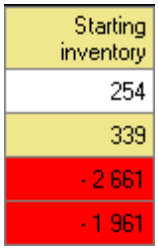


Figure 20: Column *Starting inventory* of dry rough showing negative inventory

The column *Drying production* shows the volume of wood that has completed its drying process and becomes available for finishing.

The column *Incoming from other mills* shows the volume of rough dry that was shipped from other mills to the current mill. Inversely, if you have more than one mill with transfer links defined, you will see columns *Shipped to…* that will allow you to manually plan shipments of dry rough to other mills. These shipments reduce the volume that is available for finishing.

Available for finishing

The column *Available for finishing* shows the volume that can be used for the finishing production at the current mill. It is the starting inventory plus the drying production plus the incoming from the other mills minus the quantities shipped. The volume available for finishing that does not go into the finishing production constitutes the starting inventory of the following period.

Finishing production

If finishing is possible at the mill (if check box *Finishing* in the *Mills* panel is checked), you can type the finishing production in the corresponding column of the grid. That production reduces the starting inventory of the following period.

Using Microsoft Excel

Right clicking on the grid will pop up a contextual menu like the one shown in figure 6 on page 9. If you select the option *Copy grid*, you will copy all the column headers and the hidden cells which you can paste to Excel. If you select the option *Copy selected cells*, only the selected visible cells will be copied.

You can also paste data copied from Excel. The paste action will not work on the read only cells, but only on the ones having a white background.

The grid of the production plan has an intelli-paste function. It means that if you have column headers and/or period names in the data you copied from Excel, it will be pasted at the proper location if your column header/period name matches the one in the grid. A match is considered to be successful when the text of the copied column header/period name is included in the column header/period name of the grid. Intelli-paste will allow pasting to hidden columns of the grid.

Understanding the charts

Several charts are available to help you in building the production plan. You can select one of the seven charts available using the *Chart type* drop down list box, as shown in the figure below.

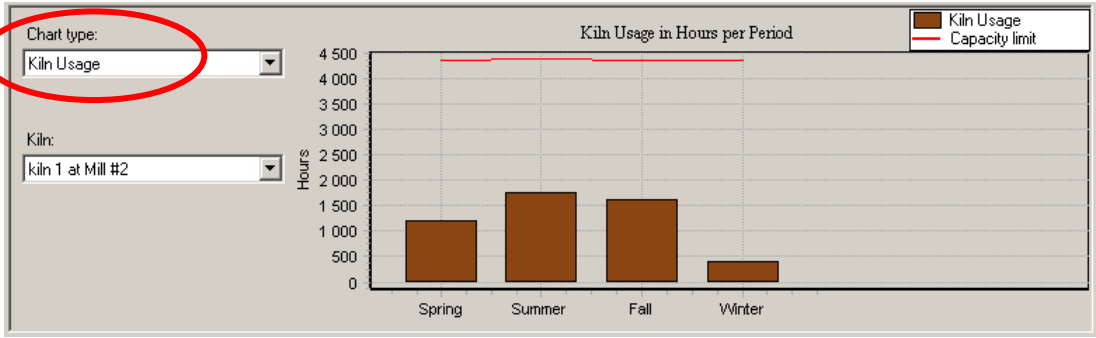


Figure 21: The *Kiln Usage* chart has been selected in the *Chart type* drop down list box

The chart is always displayed for the current mill. Also, when the chart displays inventory or production, it is for the current product.

You should note that although the grid displays the starting inventory of green rough and dry rough at the beginning of each period, the inventory chart displays the end of period inventory. Because the end inventory of the last period is not visible from the grid, you can check these charts to ensure your inventory is always positive.

The most useful charts are the one on *Kiln Usage* and *Air Drying Usage*. They are useful because they complement the information available in the grid. These charts will show a red line representing the capacity limit for the kiln or the available yard for air drying. You can then see how close you are to the capacity for your drying resources.

When you select the *Kiln Usage* chart, the drop down list box to select the kiln becomes available. You should then select the kiln for which you want to see the usage.

How is the capacity limit computed?

Let's start with the capacity limit displayed for the kiln usage. The capacity limit per period is represented by the number of hours the kiln is open for drying during the period, times the number of identical kilns.

For the air drying usage, the capacity limit per period is given by an average Mbf per day, which corresponds to the yard volume available for air drying (in Mbf), as specified in the *Air drying* tab of the *Mills* panel.

Managing the scenarios

The tool allows you to create different production plan (scenarios). The first scenario is called *initial* and cannot be renamed. You can create a new scenario by clicking the "+" button on the right of the scenario drop down selection list. Scenarios can be deleted by clicking the "-" button.

Analysis of a production plan

Once you have a production plan with no negative inventory which respects your drying resource capacity, you can evaluate its performance in terms of energy content used, greenhouse gases emissions and cost. All these measures have been divided between the transportation and the drying itself. The figure below shows the *Analysis* panel. The panel shows the result only for a given scenario.

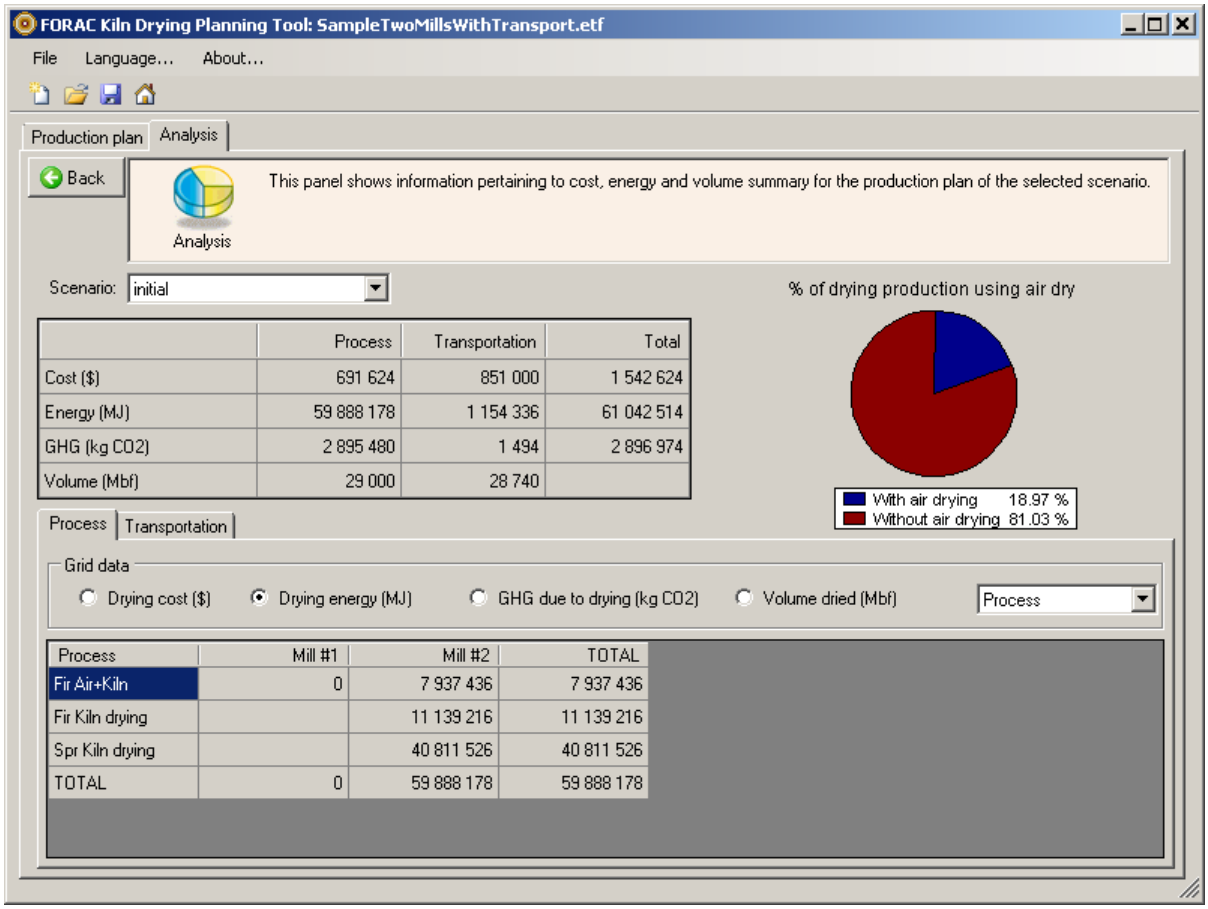


Figure 22: Analysis panel for a scenario using wood transfer

General results

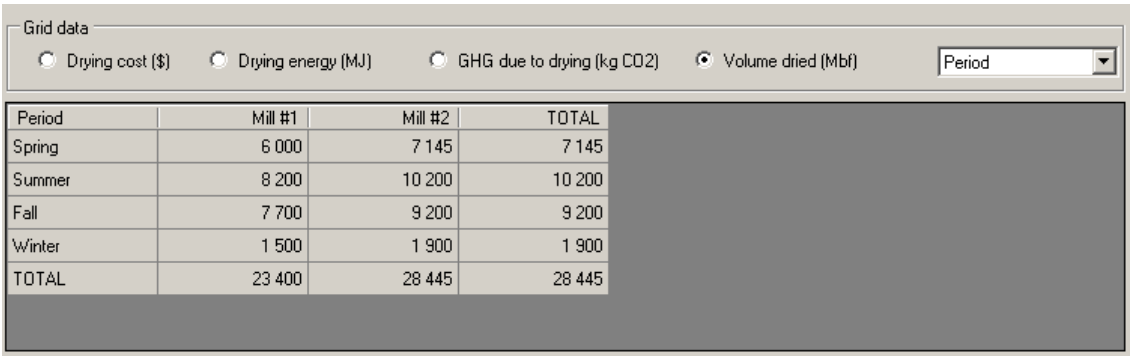
The general results are given in the upper part of the panel. You can read the different measures for the drying processes and for the wood transfer. Note that if a wood transfer is required by a process (air drying and kiln drying at different mills), the transfer will be recorded with the other manually planned shipments.

The pie chart gives you at a glance the portion of the wood production that uses air drying, with or without using kiln drying as a second operation of the drying process.

Below the grid showing the general results, you can choose to see in more detail either the measures for the transportation or the measures for the drying processes.

Process related results

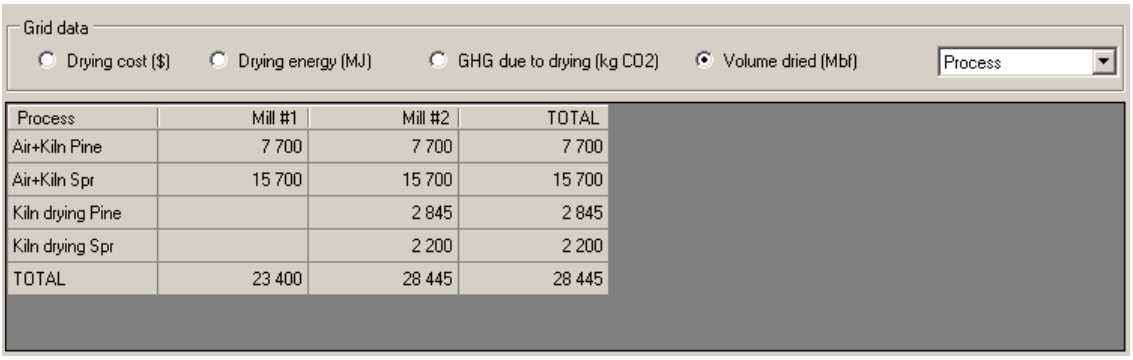
The grid will show you the measures in relation to the drying processes or the period. You can then see for example which process is used to dry most of the wood or which process is the most costly (energy-wise and money-wise). You can also get in a single view the volume dried per period at each mill (see Figure 23).



Period	Mill #1	Mill #2	TOTAL
Spring	6 000	7 145	7 145
Summer	8 200	10 200	10 200
Fall	7 700	9 200	9 200
Winter	1 500	1 900	1 900
TOTAL	23 400	28 445	28 445

Figure 23: Details of the process related results in relation with the periods

You will see that for the *Volume dried* measure, the column TOTAL is not necessarily the sum of the column's value. In the example below, only 7 700 Mbf has been dried in total using the process *Air+Kiln Pine* as this process starts with air drying at mill #1 and proceeds with kiln dry at mill #2.



Process	Mill #1	Mill #2	TOTAL
Air+Kiln Pine	7 700	7 700	7 700
Air+Kiln Spr	15 700	15 700	15 700
Kiln drying Pine		2 845	2 845
Kiln drying Spr		2 200	2 200
TOTAL	23 400	28 445	28 445

Figure 24: Details of the process related results (grid shows volume dried in Mbf)

Costs, energy content usage and greenhouse gases emission due to wood transfer within processes are not included in this tab. They are summed up in the transportation tab.

Transportation related results

These results show both the transfers manually set up by yourself in the production plan as well as the transfers resulting in the use of processes requiring wood transfer (when the air dry operation and the kiln dry operation of a process are not done at the same mill).

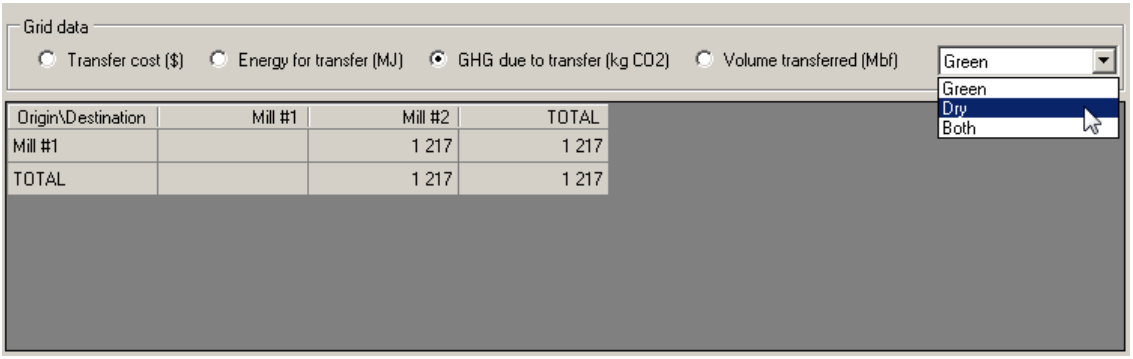


Figure 25: Details of the transfer related results

The results are shown in a matrix of the form origin/destination. You can then evaluate which links are the most costly to you and review your production plan to reduce these transfers. The grid can show either the transfer of green rough, dry rough or both summed up. Note that an automatic transfer of wood within a process is considered for green rough since after such a transfer there is still a kiln drying operation to be completed.

Comparing Scenarios

When you create different scenarios from within the production plan view, you can compare them by having side to side the qualitative values of each scenario, like showed in the figure below where you can see two scenario being compared: initial and 25%. There is no limit on the number of scenarios that can be showed simultaneously.

In the more detailed grid at the bottom of the window, you can look at the result by period or by process. When transportation can occur (for multi-locations dataset), the special row "** transportation" appear, showing the data value related to the transportation of wood between mills.

As for the other grids, you can copy and paste values to Excel.

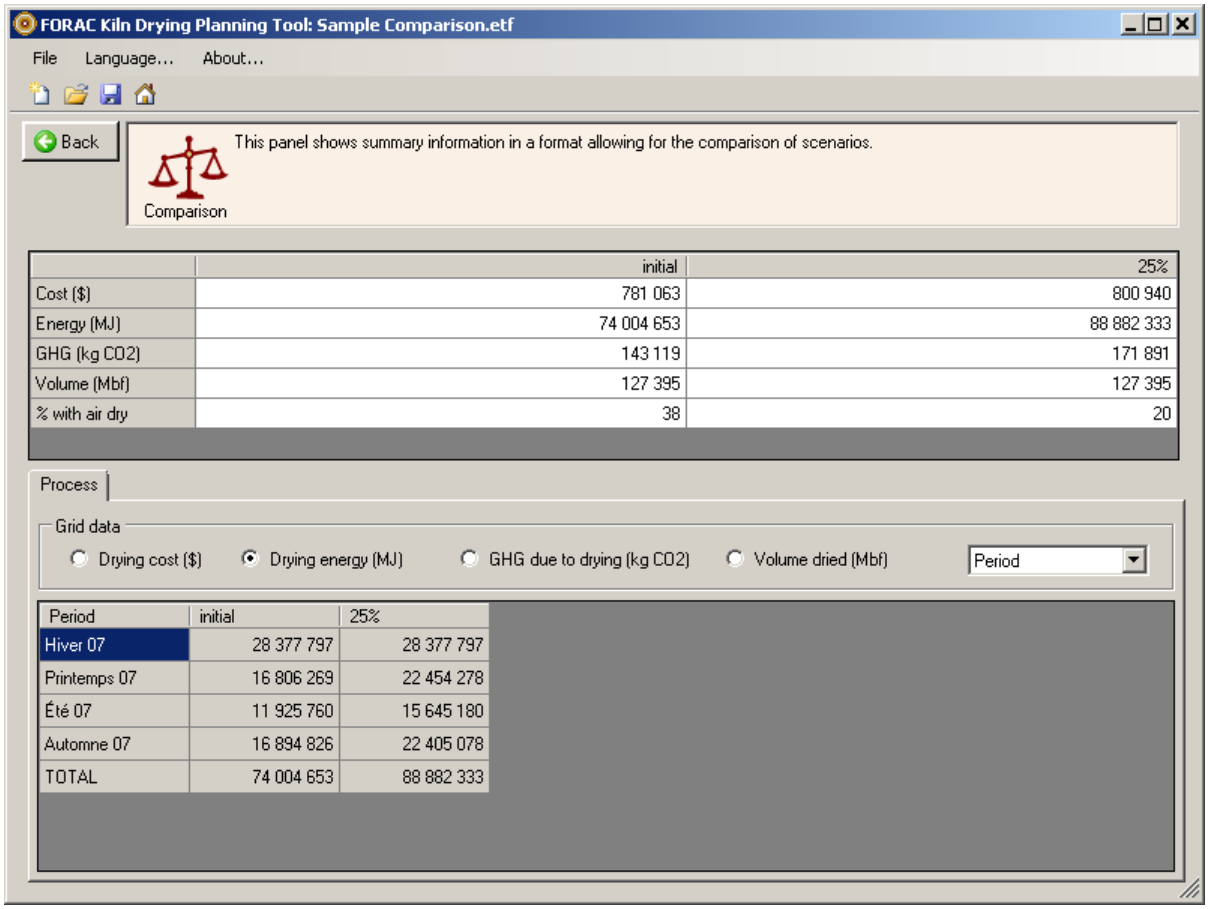

FORAC Kiln Drying Planning Tool: Sample Comparison.etf
File
Language...
About...
Back
This panel shows summary information in a format allowing for the comparison of scenarios.
Comparison
initial
25%
Cost ($) 781 063 800 940
Energy (MJ) 74 004 653 88 882 333
GHG (kg CO2) 143 119 171 891
Volume (Mbf) 127 395 127 395
% with air dry 38 20
Process
Grid data
Drying cost ($)
Drying energy (MJ)
GHG due to drying (kg CO2)
Volume dried (Mbf)
Period
Period initial 25%
Hiver 07 28 377 797 28 377 797
Printemps 07 16 806 269 22 454 278
Été 07 11 925 760 15 645 180
Automne 07 16 894 826 22 405 078
TOTAL 74 004 653 88 882 333

Figure 26: Scenarios comparison

To get a little more out of the tool

The tool is interesting to help you make a production plan that will not exceed your drying resource capacity. You can also evaluate diverse scenarios using different drying processes, balancing your inventory differently in time and see how your plans compare money-wise and energy-wise. You can set up a comparison sheet in Excel and copy the results of the *Analysis* panel for each of your potential scenarios.

To go further, you could imagine that you have an extra kiln at one of your mills or that you change the energy type of one of your kilns. Create a dataset for that scenario and see how this affects the drying capacity, the energy consumption and the cost of your current best scenario. You can then more easily argue the pros and the cons of making an investment in this new drying technology.

Questions or problems?

If you have any questions or problems, you can send an email to info@forac.ulaval.ca with the release number of the tool you are using (see the *About* dialog box), a description of your subject and a phone number where you can be reached. A member of our personnel will contact you by email or by phone to work attend to the subject.